

Claims

- [c1] 1.A method for breaking down pieces of material into smaller pieces and for separating out different substances making up said material, one of said substances being a fibrous textile and another being metal, comprising the steps of:
- subjecting said pieces to a series of dismemberments to produce progressively smaller pieces falling within a predetermined size range;
- separating said smaller pieces into a plurality of fractions, each fraction including pieces within a predetermined size range; and
- subjecting each said fraction to a flow of air calibrated to cause separation of said fibrous textile material from said pieces.
- [c2] 2.The method of claim 1 wherein said dismembered pieces are exposed to one or more magnets to remove said metal.
- [c3] 3.The method of claim 2 wherein said pieces are subjected to at least one vibratory screening for separation of said pieces from said fibrous textile.
- [c4] 4.The method of claim 3 wherein said step of subjecting each said fraction to a flow of air occurs after said at least one vibratory screening, and the fibrous textile removed by said flow of air is returned to said at least one vibratory screening and added to said material being screened.
- [c5] 5.The method of claim 4 wherein said fractions subjected to said flow of air are discharged onto vibrating air table means that are at least partially enclosed a within housing means, said fractions there being subjected to a flow of updraft air at a rate causing additional separation of said fibrous textile from said fractions.
- [c6] 6.The method of claim 5 wherein said pieces are subjected to at least three vibratory screenings for separation of said fibrous textile material.
- [c7] 7.The method of claim 6 wherein in at least one of said vibratory screenings, said pieces are divided into undersize and oversize pieces, said oversize pieces being returned for additional dismemberment until said pieces are undersized.

- [c8] 8.The method of claim 7 wherein said pieces of material are used tires or pieces of said tires, said metal is wire and said fibrous textile consists of cord.
- [c9] 9.Apparatus for processing a feedstock consisting of a first material comprising particles of different sizes mixed with a second lighter material to be separated from said first material, comprising:
means for separating said feedstock into two or more fractions, each said fraction including particles of said first material falling within a predetermined size range;
an enclosure for receiving one of each said fractions in a stream passing therethrough;
ventilator means causing a flow of air to intersect said stream of particles in said enclosure; and
means for adjusting the flow rate of said air having regard to said size range of said particles, wherein said airflow carries away some or all of said second material for separation from said first material.
- [c10] 10.The apparatus of claim 9 further including air table means having an upper surface and adapted for the flow of air in an upwards direction therethrough, said fractions of particulates being discharged from respective ones of said enclosures onto said upper surface wherein said flow of air separates out additional of said second material from said first material for removal.
- [c11] 11.The apparatus of claim 10 wherein said upper surface is divided into segments, each said segment receiving a respective one of said fractions.
- [c12] 12.The apparatus of claim 11 wherein said upward flow of air through each of said segments is adjusted having regard to the size of said particles in said segment.
- [c13] 13.The apparatus of claim 12 wherein said air table means are vibratory for agitation of said particles on said upper surface thereof.
- [c14] 14.The apparatus of claim 13 wherein said means for adjusting comprise at least one damper pivotally disposed in said enclosure and being adjustable to increase or decrease said flow of air intersecting said stream of particles.

- [c15] 15.The apparatus of claim 14 wherein said ventilator means comprise a suction blower for drawing air into said enclosure, through said stream of particles and out of said enclosure with said second material entrained in said air flowing out of said enclosure.
- [c16] 16.The apparatus of claim 15 wherein said air table is disposed within a housing, said housing including an outlet in fluid communication with means drawing air out of said housing, said air having entrained therein said second material separated from said first material by said upward flow of air through said air table.
- [c17] 17.The apparatus of claim 16 wherein said first material is crumb rubber and said second material is a fibrous textile.
- [c18] 18.A method of treating a particulate material cryogenically to produce smaller particles, comprising the steps of:
cooling said material to cryogenic temperatures;
feeding said cooled material at a predetermined rate between at least one pair of closely spaced, counter-rotating rollers for reducing the size of said particles, one roller of said pair rotating at a first predetermined speed, and the second of said rollers rotating at a second higher predetermined speed; and thereafter subjecting said material to hammering for producing yet smaller particles.
- [c19] 19.The method of claim 18 wherein said cooled material is fed between at least two pairs of said rollers.
- [c20] 20.The method of claim 19 wherein said at least two pairs of rollers are arranged in vertical alignment with said first pair being disposed above said second pair.
- [c21] 21.The method of claim 20 wherein cryogenic gas is added as said material passes through said pairs of rollers for additional cooling of said material during treatment between said pairs of rollers.
- [c22] 22.The method of claim 21 wherein the speed differential between the rollers of

each said pair thereof is in the range of 10:1.

- [c23] 23.The method of claim 21 wherein the speed differential is 3 to 4:1 and is preferably 3.29:1.
- [c24] 24.The method of claim 21 wherein cryogenic gas is added to said material during said hammering thereof.
- [c25] 25.The method of claim 24 wherein said cooling of said material comprises the steps of first pre-cooling said material using cryogenic gas and then cooling said material by submersion in a cryogenic liquid.
- [c26] 26.The method of claim 25 wherein said material is crumb rubber, said cryogenic gas is nitrogen gas and said cryogenic liquid is liquid nitrogen.
- [c27] 27.Apparatus for treating a particulate material cryogenically to produce smaller particles, comprising:
freezer means wherein said material is cooled to cryogenic temperatures;
at least a first pair of closely spaced apart, counter-rotating rollers sealed in a housing for receiving said cooled material therebetween for a first reduction in the size of said particles;
means for driving each roller of said pair at a selected, predetermined rotational speed; and
means for receiving and storing said material following said cryogenic treatment thereof between said rollers.
- [c28] 28.The apparatus of claim 27 further comprising a second pair of closely spaced counter-rotating rollers sealed in a housing for receiving therebetween said material from said first pair of rollers for a second reduction in the size of said particles, and means for driving each roller of said second pair at a selected, predetermined rotational speed.
- [c29] 29.The apparatus of claim 28 wherein said rollers are spaced apart by a small gap of adjustable width selected to cause a reduction in the size of said particles.
- [c30] 30.The apparatus of claim 29 further comprising hammering means for

receiving therein said material from either or both of said first and second pairs of rollers for a third reduction in the size of said particles.

[c31] 31.The apparatus of claim 30 wherein one roller of each of said first and second pair of rollers is driven by said drive means at a first predetermined rotational speed, and the second roller of each of said first and second pair is driven by said drive means at a second higher predetermined speed.

[c32] 32.The apparatus of claim 31 wherein the speed differential between said rollers of each said pair thereof is in the range of 10:1 to 1.1:1.

[c33] 33.The apparatus of claim 31 wherein said speed differential is 3 or 4:1 and is preferably 3.29:1.

[c34] 34.The apparatus of claim 33 wherein said first pair of rollers is arranged above said second pair of rollers in parallel, vertical alignment therewith, the vertically aligned rollers to one side of said gap being connected by a drive member for rotation in one direction, and the vertically aligned rollers to the other side of said gap being connected by another drive member for rotation in the opposite direction, wherein said particles are drawn into, between and through said gap between each of said pairs of rollers, each said drive member being operationally connected to a prime mover for rotation of said rollers.

[c35] 35.The apparatus of claim 34 wherein said drive means are arranged so that the diagonally opposite rollers of each of said first and second pairs are driven at substantially the same rotational speed.

[c36] 36.The apparatus of claim 35 wherein said predetermined speed is approximately 700 rpm, and said second higher predetermined speed is approximately 2300 rpm.

[c37] 37.The apparatus of claim 36 wherein said gap between said rollers is adjustably maintained in the range from 0.001" to 0.01", and preferably in the range from 0.002" to 0.007".

[c38] 38.The apparatus of claim 37 wherein said gap is independently adjustable from either end of said rollers to be the same or variable in width along its length

between said rollers.

- [c39] 39.The apparatus of claim 38 wherein the surface of each roller is textured to facilitate treatment of said particulates.
- [c40] 40.The apparatus of claim 39 wherein the surface of each roller includes spirally arranged longitudinally extending corrugations spaced apart at a predetermined pitch.
- [c41] 41.The apparatus of claim 40 wherein said corrugations spiral at the rate of $\frac{1}{2}$ " per foot, the pitch of said corrugations being selectable in the range between 22 and 36.
- [c42] 42.The apparatus of claim 41 wherein the profile of said corrugations is Allis Dull.
- [c43] 43.The apparatus of claim 42 wherein said freezer means are partially filled with cryogenic liquid whereby some of said particulates are submerged below the level of said liquid for cooling and some are disposed above said liquid for pre-cooling by the vaporized gas from said cryogenic liquid.
- [c44] 44.The apparatus of claim 43 wherein said cryogenic gas from said freezer means is discharged into said housings for said roller means for additional cooling of said particulates during treatment therein.
- [c45] 45.The apparatus of claim 44 wherein cryogenic gas from said housings is discharged into said hammering means for additional cooling of said particulates during treatment therein.
- [c46] 46.The apparatus of claim 45 wherein rotation of the rollers of either or both of said first and second pairs thereof at different rotational speeds promotes both grinding and shearing of the particles to reduce their size.
- [c47] 47.The apparatus of claim 27 wherein said particulate material is crumb rubber.
- [c48] 48.A method of sorting a material into separate fractions, each fraction including particulates of said material falling within a predetermined size range, comprising the steps of:

adding a flow agent to said material and mixing said material and said flow agent together, said flow agent being selected to increase the recovery of the smallest particles of said material;
sorting said material through a plurality of screens to cut said material into said fractions; and
collecting said fractions for packaging or storage.

- [c49] 49.The method of claim 48 wherein said flow agent is carbon black.
- [c50] 50.The method of claim 49 wherein said carbon black is Cabot Corporation carbon black product Nos. N990 or N234, or carbon black having characteristics similar thereto.
- [c51] 51.The method of claim 50 wherein said carbon black is added to said material in an amount from approximately 0.25% to about 2% by volume of said mixture.
- [c52] 52.The method of claim 51 wherein said material is crumb rubber and said carbon black increases the recovery of crumb rubber particles smaller than 100 mesh.